Quantifying Economic Benefits of Weather and Climate Forecasts

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Overview

1. How Weather Forecasts create economic benefits
2. How quantifying benefits of Weather/Climate Forecasts supports Meteorological Services
3. Quantitative work underway in the United States

Weather/Climate Forecasts Create Value

- Weather has economic impacts
- Nearly 30 percent of U.S.'s GDP is directly or indirectly affected by weather
  - $3 trillion ranging from finance to retail trade
  - $1 trillion in direct impacts (e.g., agriculture, space heating and cooling, construction, and outdoor recreation)
- With a reliable forecast, better decisions often can be made. Hence, reliable forecasts have economic value

How to Measure the Value of Weather Forecast?

- Identify decisions that can be improved using a reliable forecast
- Value expected economic outcomes, when the best decisions are made
  - with weather forecast
  - and without forecast
- Difference between values with and without forecast is the expected value of the forecast

How Quantifying Benefits of Weather/Climate Forecasts Support Meteorological Services

- Can support Meteorological Services and Operations at several levels
  - Understanding how forecast are used in decision-making can improve and target operations
  - Justify budgets
  - Cost/benefit analysis to prioritize programs
  - Policy analysis (user fees, pricing, public/private sector interface, etc.)

Some of the Quantitative Work Underway in NOAA

- Weather
  - Benefits of daily forecasts to U.S. households √
  - Urban heat wave warning systems √
  - Hurricane warnings to households (underway)
  - Electricity generation (underway)
  - Drought forecasting (underway)
- Climate (ENSO)
  - Agriculture √
  - Fisheries √
  - Hydro-electric generation (underway)
  - Natural gas storage and distribution (underway)

Value of Daily Weather Forecasts in the U.S. Household Sector

- The 105 million households are the largest user of NOAA products, consulting the forecast at least once a day
- Because daily forecast are not purchased in the market every day, valuing them is a challenge
- Study is the first to apply state-of-the-art “non-market” valuation techniques to weather
  - Contingent valuation
  - Conjoint analysis
- Study has received extensive peer-review

Best Estimates of Annual U.S. Economic Benefits of Daily Forecast (willingness-to-pay)

	Per Household	Total (Billion)
Current Forecasts	$109	$11.44
Improved Forecasts	$16	$1.73
Cost of Current NOAA System (O&M & Capital)	$13	$1.38

Benefits of Hurricane Warnings

- Benefits of better warnings include “market” benefits such as reduced costs of evacuation (e.g., $1 million per mile avoided)
- But benefits also include “non-market” benefits - - willingness-to-pay for reduced time, expense, and anxiety in storm preparation
- Hurricane study underway focuses on measuring these non-market benefits, similar to the Household study; targets hurricane prone populations

Benefits of Urban Heat Wave Warning Systems

- Ten systems operating in United States; Philadelphia since 1995
- Uses weather forecast information to decide whether to issue a heat wave warning
- When a heat wave warning is issued, the city of Philadelphia takes steps to reduce the risk of heat related mortality
  - Public announcements – buddy systems
  - Telephone Heatline
  - Public Health Department home visits
  - Senior center hours extended – provide A/C
  - Homeless outreach

Heat Wave Warnings

Costs of the Actions taken are comparatively low

- Three year costs on the order of $200,000

Benefits -- reduced “excess mortality” -- are large

- Saved 117 lives from 1995-98
- Benefits estimated at $468 million over 3 years

Value of Weather Forecasts to Electricity Generators

Generating units have different startup leadtimes, fixed costs of operation, and unit costs of production

Start-up decisions are made in advance of anticipated future loads

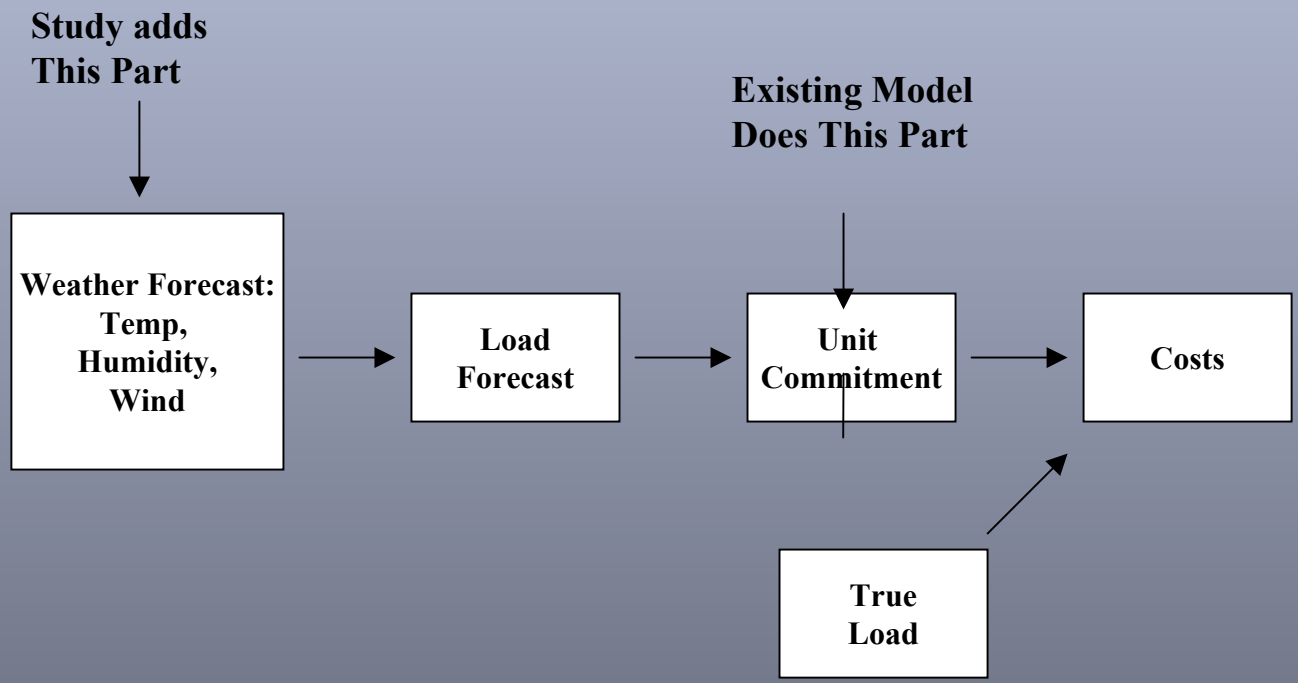
Future loads must be forecast and weather forecasts are a key

Bad Forecasts Increase Costs

- When too high, high start-up cost units started unnecessarily
- When too low, high unit cost power may have to be purchased or generated

Electricity Generators (cont'd)

Our study connects daily weather forecast with the utility's next day load forecast



Sample includes utilities across the United States. Initial results show significant value

Climate Forecast Benefits

- NOAA has become proficient at forecasting weather patterns driven by the ENSO phenomenon (EL Nino, La Nina)
- We can make ENSO forecasts six to nine months in advance
- Longer term forecasts allow more opportunity for decisions to be responsive to forecasts

Benefits of ENSO Forecasts

- Better forecast-based storm preparation in California helped reduce losses in the big 97-97' EL Nino by $1 billion relative to the 82-83' El Nino
- Benefits to U.S. Agriculture: $200 - $300 million/year
- Benefits to Mexican agriculture: $10 - $25 million/year
- World-wide agriculture benefits: at least $450 to $550 million/year

ENSO Examples (cont'd)

- Improved U.S. corn storage decisions: $200 million/year
- Forecast-based management of world rice stocks: $23 billion/year (preliminary)
- Forecasts for small NW salmon fishery in U.S.: $1 million/year

But, Benefits of Weather/Climate Forecasts Can Be Limited

- Studied large Hydro electric system in United States
- Reservoir stream flows are ±30 percent in ENSO years
- The El Nino of 1997-98 was predicted to produce a wet fall and dry spring
- However, a non-typical circulation pattern developed, producing the opposite result
- So even with a perfectly accurate ENSO prediction, weather uncertainty persists, particularly at the local level

References

All Benefit Numbers are contained and referenced in *Economic Statistics for NOAA*, (March 2003 Revised edition) U.S. Department of Commerce, NOAA, Washington, D.C.
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